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(54)【発明の名称】　インクジェット式印字ヘッド

(57)【特許請求の範囲】

【請求項１】　ノズル開口に対応して配列された圧電素子に駆動信号が印加されることにより、前記ノズル開口からインクを外部に放出するインクジェット式印字ヘッドにおいて、

前記圧電素子は、圧電材料と導電材料を交互に複数積層してなり、前記導電材料の一部が電圧が印加されないダミー導電材料層であることを特徴とするインクジェット式印字ヘッド。

【請求項２】　前記圧電素子は、基台上に固定された後個々の圧電素子に分割されて形成されたことを特徴とする請求項１記載のインクジェット式印字ヘッド。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、インクジェットプリンターに用いる印字ヘッドに関する。

【０００２】

【従来の技術】従来のインクジェット式印字ヘッドは、日本特許公報、特公昭６０－８９５３号公報に示されたように、インクタンクを構成する容器の壁面に複数のノズル開口を形成すると共に、各ノズル開口と対向するように伸縮方向を一致させて圧電素子を配設して構成されている。この印字ヘッドは、駆動信号を圧電素子に印加して圧電素子を伸縮させ、この時に発生するインクの動圧によりインク滴をノズル開口から吐出させて印刷用紙にドットを形成するものである。

【０００３】このような形式の印字ヘッドに於いては、液滴の形成効率や飛翔力が大きいことが望ましい。しかしながら、圧電素子の単位長さ、及び単位電圧当りの伸縮率は極めて小さいため、印字に要求される飛翔力を得

るには高い電圧を印加することが必要となり、駆動回路や電気絶縁対策が複雑化するという問題がある。

【0004】このような問題を解決するため、日本特許公報特開昭63－295269号公報に示されているように、電極と圧電材料とを交互にサンドイッチ状に積層したインクジェット印字ヘッド用の圧電素子が提案されている。この圧電素子によれば電極間距離を可及的に小さくすることが出来るため、駆動信号の電圧を下げることが出来るという効果がある。

【0005】

【発明が解決しようとする課題】しかしながら、このような圧電素子は小型に成形することが困難であり、その用途が限定されるという問題がある。

【0006】本発明の目的は、圧電素子を容易に小型化することのできるインクジェット式印字ヘッドを提供することにある。

【0007】

【課題を解決するための手段】上記課題を解決するために本発明に於いては、圧電材料と導電材料をそれぞれに交互に層状に積層し、前記圧電素子は、部分的に電圧のかからないダミー導電材料層を有する構造にした。

【0008】

【実施例】図1に本発明に於けるインクジェット式印字ヘッドの1例を示す。図1に於て、11は基台、12は接着剤、13は個別電極、14は圧電素子列、15はノズルを形成した板材（以下、ノズルプレートと称す。）、16はダミー電極、17はインク流路である。

【0009】本ヘッドは以下の工程で製造される。

【0010】図2に於て、定板21の上にグリーンシート状、又は、ペースト状に調製したチタン酸ジルコン酸鉛系複合ペロブスカイトセラミック等の圧電材料22を塗布して、図3に示すようにこれの表面に一方の電極となる第1の導電材料23を、Ａｇ、Ｐｄ等の導電ペーストを厚膜印刷法を用いて形成する。さらに図4に於てこの導電層23の表面に圧電材料22を塗布し、この上面に図5のように他方の電極となる導電材料24およびダミー導電材料25を前記の方法で塗布する。後は、前記の方法で導電層と圧電材料を必要な積層数だけ繰り返し塗布し、所望の厚みに積層した状態、図6で乾燥させる。

【0011】これに圧力を加えた状態で焼成することにより図7に示すような、直方体状の圧電素子31が形成される。この圧電素子31の導電層23、24が露出している面に外部電極32、33を形成して乾燥する。ここでの外部電極の形成方法は、厚膜プロセスでも薄膜プロセスでも良いが、膜厚の均一性、密着強度の点で薄膜プロセスの方が適している。又、ここで、印刷時厚み寸法は、焼成時に収縮する為、予め収縮率を加味して各層を所望の寸法より厚く印刷しなくてはならない。この収縮率は、選定する導電材料、圧電材料、焼成条件により異なるが、約1～50％程度である。

【0012】上記の工程で製造された圧電素子31に図8に示すように、導電膜32、33と対応して個別電極13と、外部接続用導体パターン41を形成した基台11上に、図9に示すように圧電素子31を接着剤12により固定する。このようにして固定した圧電素子31は、図10に示すように個別電極ピッチと同ピッチで細かくダイヤモンドカッター等で切込み41をいれる。この後個別電極13と切込みの入った圧電素子列14とを接続する。ここでの接着剤は、電極32と基台11上に形成された個別電極13とを電気的に接続する必要があるため、半田、導電性接着剤等の導電ペースト19にして接続する方法が最適である。次に、ダイヤモンドカッター等で切込みの入った隙間に、信頼性向上のためインクが流れ込むのを防止するよう耐湿性材料等でを圧電素子周囲を保護しても良い。ここで、耐湿性材料に気泡が入るのを除去するため真空脱泡等の処理を行なうのが望ましい。

【0013】次に、インク流路、ノズルプレートを形成し、その結果、図1に示したヘッド構造を得る。

【0014】（比較例）本構造の圧電素子と、図11に示したダミー電極のない圧電素子と試作比較した例を示す。試作したサンプル形状は、図12に示す様にＷ18×Ｌ8×ｔ0．5である。

【0015】図13は、ダミー電極の有る圧電素子の平面状態で図14はダミー電極の無い圧電素子の平面状態である。図13、図14に於て、（ａ）は長さ方向のそり、うねり状態。（ｂ）は、幅方向のそり、うねり状態である。本試作によれば、ダミー電極を形成したサンプルは、焼結工程での歪を小さくする事が可能な為、図13に示すように平坦な圧電素子を得ることが出来る。

【0016】

【表1】

表１；（そり、うねり）

	ダミー電極有り	ダミー電極無し
長さ方向	１０μm以下	約１００μm
幅方向	５μm以下	約　２０μm

【００１７】

【発明の効果】本発明のインクジェット式印字ヘッドによれば、圧電素子が、圧電材料と導電材料を交互に複数積層してなり、前記導電材料の一部が電圧が印加されないダミー導電材料層であることにより、圧電素子焼成時に発生する応力歪みによる圧電素子の変形を緩和することができる。これにより圧電素子の方向ばらつきを抑えることができ、信頼性の高いインクジェット式印字ヘッドを提供することができる。

【図面の簡単な説明】

【図１】本発明のインクジェット式印字ヘッドの構造を示す断面図。

【図２】本発明のインクジェット式印字ヘッドの製造工程を示す断面図。

【図３】本発明のインクジェット式印字ヘッドの製造工程を示す断面図。

【図４】本発明のインクジェット式印字ヘッドの製造工程を示す断面図。

【図５】本発明のインクジェット式印字ヘッドの製造工程を示す断面図。

【図６】本発明のインクジェット式印字ヘッドの製造工程を示す断面図。

【図７】本発明のインクジェット式印字ヘッドの製造工程を示す断面図。

【図８】本発明のインクジェット式印字ヘッドの製造工程を示す断面図。

【図９】本発明のインクジェット式印字ヘッドの製造工程を示す断面図。

【図１０】本発明のインクジェット式印字ヘッドの製造工程を示す断面図。

【図１１】比較例を示す断面図。

【図１２】試作した圧電素子形状と、そり、うねりの測定方向を示す上面図。

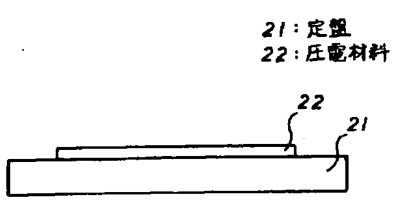
【図１３】本発明の圧電素子の表面状態を表面粗さ計で測定したデータグラフ。

【図１４】比較例の圧電素子の表面状態を表面粗さ計で測定したデータグラフ。

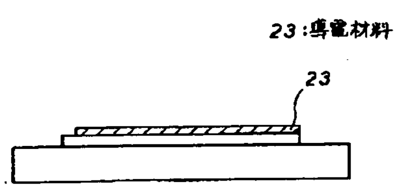
【符号の説明】

１１　基台
１２　接着剤
１３　個別電極
１４　圧電素子列
１５　ノズルプレート
１６　ダミー電極
１７　インク流路
１８　コモン電極
２５　ダミー導電材料

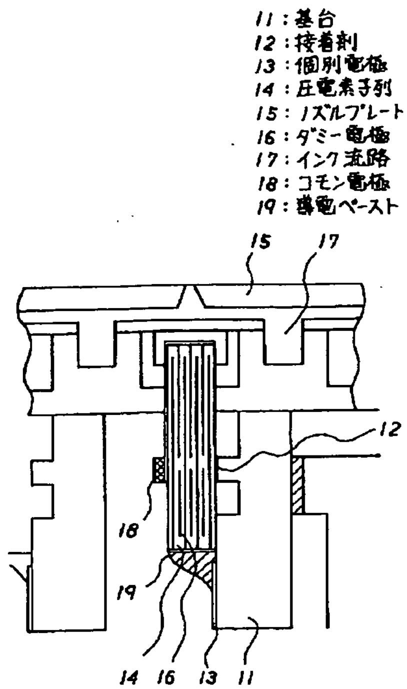
【図２】



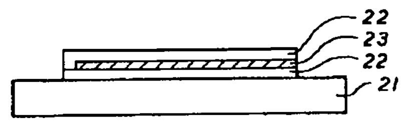
【図３】



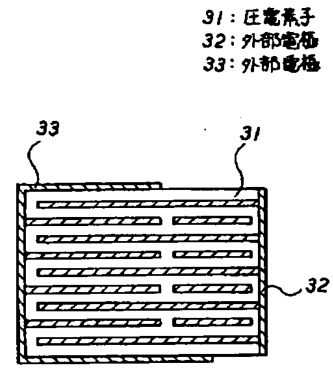
【図１】



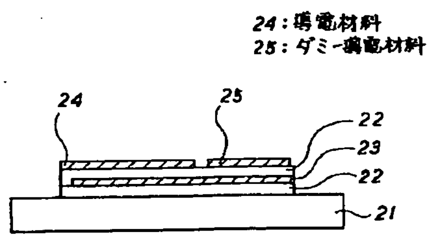
【図４】



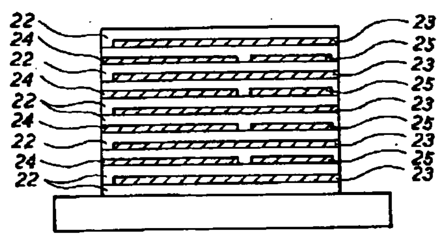
【図７】



【図５】



【図６】



【図８】

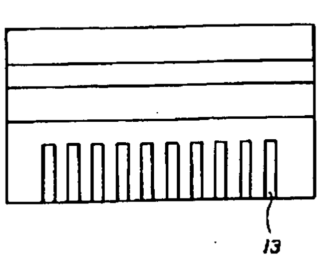
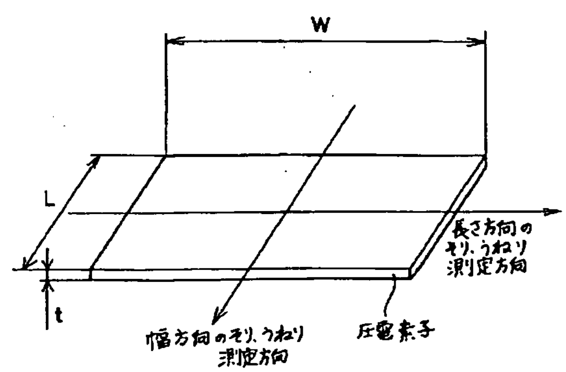


図８（a）

図８（b）

【図１２】



【図９】

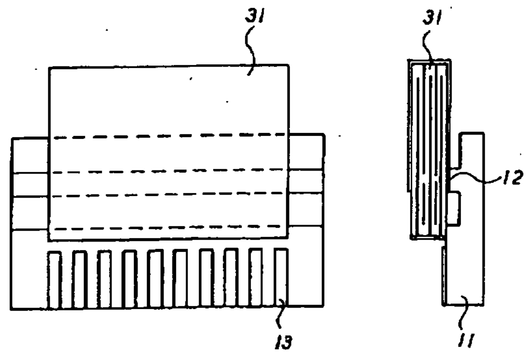


図9 (a) 図 9(b)

【図１０】

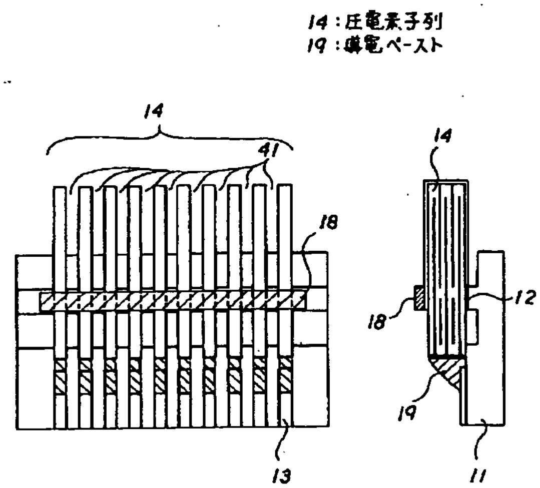
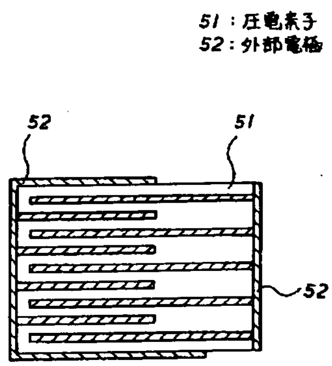
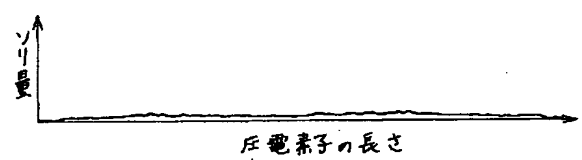


図10(a) 図10(b)

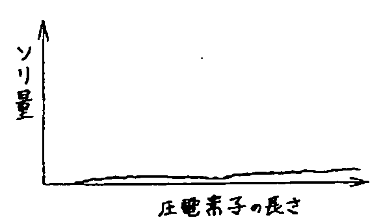
【図１１】



【図１３】



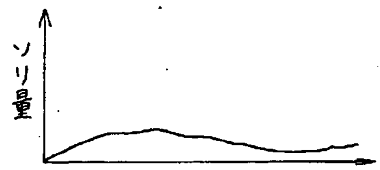
(a)



(b)

【図１４】

(a)



(b)

INK JET TYPE PRINTING HEAD

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Inventor(s):	SONEHARA HIDEAKI
Applicant(s):	SEIKO EPSON CORP
Requested Patent:	JP4235041
Application Number:	JP19910000944 19910109
Priority Number(s):	
IPC Classification:	B41J2/045; B41J2/055; B41J2/16; H01L41/09
EC Classification:	
Equivalents:	JP2987944B2

Abstract

PURPOSE:To relax the stress strain at the time of the baking of a piezoelectric element and to suppress the irregularity of the individual piezoelectric element by realizing a laminated piezoelectric element from the piezoelectric element and a dummy electrode to which no voltage is partially applied.
CONSTITUTION:A laminated piezoelectric element 31 is formed by coating the surface of a conductive layer 23 with a piezoelectric material 22 and further coating the same with a conductive material 24 and a dummy conductive material 25 and further cut to form a piezoelectric element row 14 and a dummy electrode 16.

* NOTICES *

CLAIMS

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(57) [Claim(s)]
[Claim 1] Narrow-band laser equipment characterized by providing the following. The laser generating section which generates a laser beam with laser activity The narrow-band-ized means which is arranged in the end side of said laser generating section on the optical axis of a laser beam generated in this laser generating section, turns up the laser beam which narrow-band-ized said laser beam and narrow-band-ized it by at least one angular dispersion mold wavelength selection component, and carries out outgoing radiation to said laser generating section A beam cuff means to turn up the laser beam by which was arranged by the other end of said laser generating section on the optical axis of a laser beam generated in said laser generating section, and incidence was carried out to it, and to reflect in said laser generating section It is arranged between said laser generating section and said narrow-band-ized means, and the light transmission field and deviation field which separate spatially the laser beam by which incidence is carried out about a laser beam cross-section field from said laser generating section are prepared. The laser branching optical unit which deflects in the direction which does not carry out incidence of the remaining laser beams to said laser generating section again through this deviation field, and is taken out as an output light while making some laser beams penetrate through this light transmission field and carrying out incidence to said narrow-band-ized means
[Claim 2] While setting up so that the optical axis of said narrow-band-ized means and the optical axis of the laser beam turned up by said beam cuff means may carry out abbreviation coincidence, said laser branching optical unit Narrow-band laser equipment given in the 1st term of a claim with which a light transmission field and a deviation field are arranged so that a laser beam transparency field may exist in the interior of the laser beam cross section by which outgoing radiation is carried out from said laser generating section and the deviation field which deflects a laser beam to the outside field of the light transmission field may exist.
[Claim 3] Said deviation field of said laser branching optical unit While consisting of two parallel different fields, the field of the one side which faced across said light transmission field, and the field of the other side Narrow-band laser equipment given in the 1st term of a claim set up so that the location about a right-angled direction may be located in the deviation direction of said laser beam of the edge by the side of the location about a direction right-angled in the deviation direction of said laser beam of the edge by the side of the light transmission field of one [said] field, and the light transmission field of the field of said another side.
[Claim 4] Narrow-band laser equipment given in the 3rd term of a claim further equipped with the light transmission field adjustable means which makes adjustable width of face of said light transmission field about the direction of angular dispersion of said angular dispersion mold wavelength selection component.
[Claim 5] The optical axis of the laser beam which a light transmission field is formed in one side, and the deviation field which deflects a laser beam to the other side is formed, and is turned up with said beam cuff means said laser branching optical unit The optical axis of said narrow-band-ized means, Narrow-band laser equipment given in the 1st term of a claim which is what is set up so that it may exist between the lines which connect the core of the deviation field of said laser branching optical unit, and the core of the beam cuff field of said beam cuff means.
[Claim 6] Narrow-band laser equipment given in the 5th term of a claim further equipped with the light transmission field adjustable means which carries out adjustable [of the width of face of said light transmission field about the direction of angular dispersion of said angular dispersion mold wavelength selection component].
[Claim 7] Said laser generating section is narrow-band laser equipment given in the 5th term of a claim with which the light transmission field and deviation field of a laser branching optical unit are divided so that the boundary line which laser is generated and divides the light transmission field and deviation field of said laser branching optical unit by discharge by the discharge electrode may become parallel to the discharge direction of said discharge electrode.
[Claim 8] Said laser generating section is narrow-band laser equipment given in the 5th term of a claim with which the

light transmission field and deviation field of a laser branching optical unit are divided so that the boundary line which laser is generated and divides the light transmission field and deviation field of said laser branching optical unit by discharge by the discharge electrode may become right-angled with the discharge direction of said discharge electrode.

[Claim 9] It is narrow-band laser equipment given in the 1st term of a claim characterize by to are what said narrow-band-ized means has a polarization passage means pass only the polarization component which has a polarization flat surface parallel to a flat surface including the direction of angular dispersion of said angular dispersion mold wavelength selection component, and said laser branching optical unit deflects only the polarization component which passed with said polarization passage means, and takes out as an output light.

[Claim 10] Said narrow-band-ized means has a polarization passage means to pass only the polarization component which has a polarization flat surface parallel to a flat surface including the direction of angular dispersion of said angular dispersion mold wavelength selection component. The 1st polarization component which is arranged into the optical path by the side of the output light of said laser branching optical unit, and can pass said polarization passage means, The laser beam polarization branching unit which branches the 2nd polarization component which has the plane of polarization of this 1st polarization component, and right-angled plane of polarization, Narrow-band laser equipment given in the 1st term of a claim further equipped with a light-receiving means to receive the 2nd polarization component which branched in this laser beam polarization branching unit, and a malfunction detection means to detect the abnormalities of output light based on the output of this light-receiving means.

[Claim 11] Narrow-band laser equipment given in the 1st term of a claim further equipped with a beam width limit means to restrict the width of face about the direction of angular dispersion of said angular dispersion mold wavelength selection component of a laser beam between said laser branching optical unit and said narrow-band-ized means or between said laser branching optical unit and the laser generating section.

[Claim 12] Narrow-band laser equipment given in the 11th term of a claim further equipped with the 2nd beam width limit means which restricts the width of face about the direction of angular dispersion of said angular dispersion mold wavelength selection component of output light into the optical path by the side of the output light of said laser branching optical unit.

[Claim 13] Narrow-band laser equipment characterized by providing the following. The laser generating section which generates a laser beam with laser activity The narrow-band-ized means which is arranged in the end side of said laser generating section on the optical axis of a laser beam generated in this laser generating section, turns up the laser beam which narrow-band-ized said laser beam and narrow-band-ized it by at least one angular dispersion mold wavelength selection component, and carries out outgoing radiation to said laser generating section A beam cuff means to turn up the laser beam by which was arranged by the other end of said laser generating section on the optical axis of a laser beam generated in said laser generating section, and incidence was carried out to it, and to reflect in said laser generating section It is arranged between said laser generating section and said narrow-band-ized means, and the light transmission field and deviation field which separate spatially the laser beam by which incidence is carried out about a laser beam cross-section field from said laser generating section are prepared. While making some laser beams penetrate through this light transmission field and carrying out incidence to said narrow-band-ized means The laser branching optical unit which deflects in the direction which does not carry out incidence of the remaining laser beams to said laser generating section again through this deviation field, and is taken out as an output light, A beam width limit means to restrict the width of face of the laser beam by which incidence is carried out to said narrow-band-ized means about the direction of angular dispersion of said angular dispersion mold wavelength selection component

[Claim 14] Narrow-band laser equipment characterized by providing the following. The laser generating section which generates a laser beam with laser activity The narrow-band-ized means which is arranged in the end side of said laser generating section on the optical axis of a laser beam generated in this laser generating section, turns up the laser beam which narrow-band-ized said laser beam and narrow-band-ized it by at least one angular dispersion mold wavelength selection component, and carries out outgoing radiation to said laser generating section A beam cuff means to turn up the laser beam by which was arranged by the other end of said laser generating section on the optical axis of a laser beam generated in said laser generating section, and incidence was carried out to it, and to reflect in said laser generating section The laser branching optical unit taken out as an output light in the direction which reflects the remainder and does not irradiate said beam cuff means via said laser generating section while being arranged between said laser generating section and said narrow-band-ized means, penetrating a part of laser beam by which incidence was carried out from said laser generating section and carrying out incidence to said narrow-band-ized means

[Claim 15] It is narrow-band laser equipment given in the 14th term of a claim which is what laser is generated by discharge according [said laser generating section] to a discharge electrode, and outputs the laser beam which reflected said laser branching optical unit via the discharge excitation field between said discharge electrodes.

[Claim 16] Narrow-band laser equipment which is characterized by providing the following and which is characterized by making it like The laser generating section which generates laser by discharge by the discharge electrode The narrow-band-ized means which is arranged in the end side of said laser generating section on the optical axis of a laser beam generated in this laser generating section, turns up the laser beam which narrow-band-ized said laser beam and narrow-band-ized it by at least one angular dispersion mold wavelength selection component, and carries out outgoing radiation to said laser generating section A beam cuff means to turn up the laser beam by which was arranged by the other end of said laser generating section on the optical axis of a laser beam generated in said laser generating section, and incidence was carried out to it, and to reflect in said laser generating section While being arranged between said laser generating section and said narrow-band-ized means, penetrating a part of laser beam inputted from said laser generating section and carrying out incidence to said narrow-band-ized means The 1st beam branching unit which reflects the remainder and carries out incidence to the discharge excitation field between the discharge electrodes of said laser generating section, The 2nd laser branching optical unit which deflects the remainder and is taken out as an output light while being arranged between said beam cuff means and the laser generating section, penetrating a part of laser beam by which incidence was carried out from said laser generating section and carrying out incidence to said beam cuff means

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[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
Technical field This invention relates to amelioration of the narrow-band laser equipment used as the aligner of a semi-conductor, or the light source for optical processing.
Background technique Conventionally, since the light source of a semi-conductor aligner is high resolution more and needs to make the depth of focus deep more in connection with the densification of a semiconductor device, short wavelength-ization has been advanced. That is, the sequential shift of the light source of a semi-conductor aligner has been carried out from g line of a high-pressure mercury lamp to i line at the thing [still short wavelength / like a KrF excimer].
However, in the thing using ********** like KrF excimer laser (248nm) or ArF excimer laser (193nm) as an oscillation laser beam, there are few classes of optical material used for a projection lens, and chromatic-aberration amendment is difficult. Therefore, using the monochrome lens which omits chromatic-aberration amendment as a projection lens, narrow-band-ization of the excimer laser itself is performed, and he raises monochromaticity, and was trying to use for the light source of an aligner in this kind of excimer laser.
By the narrow-band laser that a place carries out incidence of all the output light from the laser oscillation section 160 as shown in drawing 19 to a narrow-band-ized component, since loss by the narrow-band-ized component was large, the load of a narrow-band-ized component with which the output of a laser beam becomes small became large, and there was a fault, like a problem arises in endurance. This inclination is remarkable at ArF narrow-band excimer laser with especially short wavelength. In addition, for 160, as for a narrow-band-ized component and 162, in drawing 19, the laser oscillation section and 161 are [a total reflection mirror and 163] half mirrors.
Then, it sets on the technique of excimer laser shown in JP,3-259583,A, A division mirror divides a laser beam, and carry out incidence of some this divided oscillation laser beams to a narrow-band-ized component, and the remainder is taken out as output laser. He is trying to solve the above-mentioned trouble and the configuration is shown in drawing 20 - drawing 21. In drawing 20, to the end side of the laser tubing 131 with which the laser medium was held An aperture 134, the regulation plate 136 which has slit 136a, and the high reflective mirror 135 are formed. To the other end side of the laser tubing 131 An aperture 134, the division mirror 137, the 1st etalon 138, the 2nd etalon 139, the high reflective cuff mirror 141, a beam splitter 142, a scattered plate 143, the monitor etalon 144, the condenser lens 145, the linear line sensor 146, and the oscilloscope 147 are formed.
In the starting configuration, division reflection of the part is carried out by the division mirror 137, and the laser beam which carried out outgoing radiation from the left-hand side aperture 134 is narrow-band-ized through the 1st etalon 138 and the 2nd etalon 139. It is reflected by the high reflective cuff mirror 141 and the division mirror 137, the narrow-band-ized laser beam is amplified in return and the laser excitation section 132 to the laser excitation section 132 in the laser tubing 131, and outgoing radiation is carried out through the left-hand side aperture 134 with breadth through the again same optical path as the above at an include angle theta. And a part is reflected by the division mirror 137 among the laser beams by which outgoing radiation was carried out, incidence is again carried out to the 1st etalon 138 and the 2nd etalon 139, and the remainder is outputted as output laser beam L. In addition, a part of output laser beam L (about 1%) is reflected by the beam splitter 142, incidence is carried out to the linear line sensor 146, and the monitor of the intensity distribution of a laser beam is carried out based on this sensor output.
That is, as the optic leading to [of the scattered lights, such as a beam expander,] generating is not used, while obtaining a high output light of spectral purity with few ASE (amplified spontaneous emmision light) components, he is trying to mitigate the load of a narrow-band-ized component with this conventional technique, as incidence of some laser beams which divided and this divided the laser beam by the division mirror 137 is carried out to a narrow-band-ized component.

Thus, since the etalon itself is the component which chooses whenever [incident angle] when using an etalon as a narrow-band-ized component and a wavelength selection component, aggravation of a spectrum distribution configuration does not take place, but can obtain a high output light of spectral purity with few ASE components.
However, in the case of an etalon, a trouble as shown below when it comes to short wavelength (193nm) like ArF laser occurs.
In a resonator as shown in a and drawing 20, although until can reduce the load of an etalon to some extent, a problem remains in the endurance of an etalon.
In order to set b and spectral band width to 1 or less pm, it is necessary to arrange two or more etalons, and cost becomes high.
Since c and the selection wavelength of an etalon are sharply changed with heat, controlling two or more etalons so that there is no heat fluctuation has much difficulty.
Then, it is more advantageous than the component which is not an angular dispersion mold like an etalon as a narrow-band-ized component and a wavelength selection component at the point which solves the problem which the direction which used the narrow-band and wavelength selection component of a prism beam expander and the angular dispersion mold which consists of diffraction gratings etc. described above.
Drawing 21 shows other examples shown in above-mentioned JP,3-259583,A, and he is trying to use for it the angular dispersion mold narrow-band-ized component which consists of a prism beam expander 156 and a diffraction grating 157 with this conventional technique instead of the 1st etalon 138 as a narrow-band-ized component of above-mentioned drawing 20, the 2nd etalon 139, and the high reflective cuff mirror 141.
However, like drawing 21, when the thing of an angular dispersion mold was used as a narrow-band-ized component, in order that light might diffract an angular dispersion mold narrow-band-ized component in all the directions in the field of the distributed direction, much parasitic oscillation as shown by the dotted line of drawing 2 occurred, and the spectrum distribution configuration of a beam was worsening it remarkably.
Moreover, in the technique of JP,3-259583,A shown in drawing 20 and drawing 21, it has the following common problems.
- Since the optical path of a resonator has bent by the division mirror 137, a resonator resonates on much wavelength by vibration or thermal distortion rather than is stable. An angular dispersion component tends to receive effect in things to vibration.
- If the profile irregularity of the edge section is bad in order to divide a beam using the edge section of the division mirror 137, where the wave front of a beam is distorted, in order to go into a narrow-band-ized component, a spectrum distribution configuration will get worse.
Drawing 22 shows other conventional techniques in which a resonator configuration whose load of a narrow-band-ized component decreases was adopted (JP,2-213178,A).
In the conventional technique shown in this drawing 22, the total reflection mirror 152 is installed in one side of the laser discharge tube 151, the total reflection mirror 153 is installed in another side, and the transflective mirror 154 is set between the laser discharge tube 151 and the total reflection mirror 152. Then, it used for semi-conductor exposure etc. by having made into the output light 156 light reflected in the transflective mirror 154, and after narrow-band-izing light which passes the transflective mirror 154 by the grating 155, narrow-band-ization of a laser beam is realized by returning to the laser discharge tube 151 interior.
However, with this conventional technique, the transflective mirror 154 is passed, a part of light which is narrow-band-ized by the grating 155 and is reflected in the total reflection mirror 152 returns to the laser discharge tube 151, it is amplified, and since the remaining light will be reflected and thrown away in the direction where the laser output light 156 is reverse, it becomes useless [light energy].
Since it is required for narrow-band-izing and coincidence of laser as the light source of a semi-conductor aligner to obtain a big output, using effectively the light energy generated inside the discharge tube to use excimer laser, what throws away a part of light in this way must avoid.
Thus, with conventional narrow-band laser equipment, the endurance of a narrow-band-ized component with an unstable resonator with which there is much parasitic oscillation and the configuration of spectrum distribution is distorted had a fault, such as that it is easy to be influenced with a problem of heat fluctuation with high cost, and making light energy useless.
This invention improves these points, the spectrum distribution of a laser beam is the balance, and it is excellent in stability and a durable side, and aims at offering the narrow-band laser equipment which does not make energy useless.
Indication of invention The laser generating section which generates a laser beam with laser activity in this invention there, It is arranged in the end side of said laser generating section on the optical axis of a laser beam generated in this

laser generating section. The narrow-band-ized means which narrow-band-izes said laser beam, turns up the narrow-band-ized laser beam and carries out outgoing radiation to said laser generating section by at least one angular dispersion mold wavelength selection component, A beam cuff means to turn up the laser beam by which was arranged by the other end of said laser generating section on the optical axis of a laser beam generated in said laser generating section, and incidence was carried out to it, and to reflect in said laser generating section, It is arranged between said laser generating section and said narrow-band-ized means, and while penetrating a part of laser beam by which incidence was carried out from said laser generating section and carrying out incidence to said narrow-band-ized means, he is trying to have the laser branching optical unit which deflects the remainder and is taken out as an output light.
Since it is made to carry out incidence of the light which penetrated the laser branching optical unit straightly to a narrow-band-ized means according to starting invention, it is lost that the optical path of a resonator bends, a resonance system is stabilized and the multi-wavelength oscillation in accordance with vibration is lost. Consequently, the laser output which has spectrum distribution went up narrow-band-ized effectiveness and balanced can be obtained.
Moreover, the laser generating section which generates a laser beam with laser activity according to this invention, It is arranged in the end side of said laser generating section on the optical axis of a laser beam generated in this laser generating section. The narrow-band-ized means which narrow-band-izes said laser beam, turns up the narrow-band-ized laser beam and carries out outgoing radiation to said laser generating section by at least one angular dispersion mold wavelength selection component, A beam cuff means to turn up the laser beam by which was arranged by the other end of said laser generating section on the optical axis of a laser beam generated in said laser generating section, and incidence was carried out to it, and to reflect in said laser generating section, While carrying out incidence of a part of laser beam by which was arranged between said laser generating section and said narrow-band-ized means, and incidence was carried out from said laser generating section to said narrow-band-ized means He is trying to have the laser branching optical unit which takes out the remainder as an output light, and a beam width limit means to restrict the width of face of the laser beam by which incidence is carried out to said said narrow-band-ized means about the direction of angular dispersion of said angular dispersion mold wavelength selection component.
According to starting invention, since the beam width limit means has restricted the beam to the direction of angular dispersion of a narrow-band-ized means, the laser output light which has the SUPUKUTORU distribution which was able to take the balance without parasitic oscillation can be obtained.
Easy explanation of a drawing [Drawing 1]
The top view of the narrow-band laser equipment of one example of this invention.
[Drawing 2]
Drawing showing the output spectrum of the laser beam outputted from equipment the output spectrum of the laser beam outputted from the narrow-band laser equipment of the example shown in drawing 1, and conventionally.
[Drawing 3]
Drawing showing the example of a concrete configuration of the angular dispersion mold wavelength selection component used in the example.
[Drawing 4]
Drawing showing the example of a concrete configuration of the beam clinch unit used in the example.
[Drawing 5]
The block diagram showing other one example of this invention.
[Drawing 6]
Drawing showing the laser beam of an omission while being outputted from the laser equipment of the example of drawing 5.
[Drawing 7]
Drawing showing various kinds of types of a beam output mirror replaced with and used for the perforated mirror of the example of drawing 5.
[Drawing 8]
Drawing showing the example of a configuration at the time of making the perforated mirror of drawing 5 movable.
[Drawing 9]
Drawing showing the various modifications of the beam clinch unit of the example of drawing 5.
[Drawing 10]
Drawing showing other examples of this invention.
[Drawing 11]
Drawing showing other examples of this invention.
[Drawing 12]

Drawing showing the example of further others of this invention.
[Drawing 13]
Drawing showing the example of further others of this invention.
[Drawing 14]
Drawing showing the spectrum distribution of the laser beam outputted from the laser equipment of the example of drawing 13.
[Drawing 15]
Drawing showing still more nearly another example of this invention.
[Drawing 16]
Drawing showing other examples of this invention.
[Drawing 17]
Drawing showing other examples of this invention.
[Drawing 18]
Drawing showing other examples of this invention.
[Drawing 19]
Drawing showing the conventional technique.
[Drawing 20]
Drawing showing the conventional technique.
[Drawing 21]
Drawing showing the conventional technique.
[Drawing 22]
Drawing showing the conventional technique.
The best gestalt for inventing The example of this invention is hereafter explained to a detail with reference to an accompanying drawing.
Drawing 1 shows the most fundamental configuration in each example configuration which shows the example of the narrow-band laser equipment of this invention, and is shown below.
In drawing 1, laser tubing with which, as for drawing 1, an angular dispersion mold wavelength selection component unit is contained, and, as for 2, a laser medium is contained, and 3 should carry out incidence of the laser beam. The beam branching unit which operates so that the beam clinch unit turned up in the direction to which it came, and 4 may penetrate a part of laser beam, it may carry out incidence to the angular-dispersion mold wavelength selection component unit 1, the remainder may be reflected and it may take out as an output light, the beam limit section to which 5 restricts the beam about the direction of angular dispersion of the angular-dispersion mold wavelength selection component unit 1 (the direction of A in drawing), and 6 are the beam limit sections which restrict the beam of output light.
In the configuration of this drawing 1, after the laser beam generated with the laser tubing 2 penetrates the beam branching unit 4, it passes the beam limit section 5 which has the aperture-like aperture which has the optical cutoff section to a slit or a perimeter, and incidence is carried out to the angular dispersion mold wavelength selection component unit 1 which has arranged the wavelength selection component of an angular dispersion mold. After being turned up and narrow-band-ized in the angular dispersion mold wavelength selection component unit 1, a laser beam passes the beam limit section 5 and the beam branching unit 4 again, with a predetermined angle of divergence, passes the laser tubing 2 and is amplified. The beam which passed the laser tubing 2 is turned up in the beam clinch unit 3, and is again amplified with the laser tubing 2. A part of output light from the laser tubing 2 penetrates the beam branching unit 4 and the beam limit section 5, and incidence is again carried out to the angular dispersion mold wavelength selection component unit 1. On the other hand, the remaining light is bent by being reflected in the beam branching unit 4, and is taken out as an output light.
Drawing 2 shows the spectrum distribution of the narrow-band laser equipment of this invention shown in drawing 1 as compared with the spectrum distribution of the narrow-band laser equipment of the conventional example shown in previous drawing 20. The spectrum distribution of the output light of the narrow-band laser equipment of this invention is distribution there is no parasitic oscillation and very balanced so that this drawing 2 may also show.
Thus, reason which does not have parasitic oscillation in the spectrum distribution of output light Since a and the beam limit section 5 had restricted the beam to the direction of angular dispersion of the narrow-band-ized means 1, parasitic oscillation was lost.
Since it was made to carry out incidence of the light which penetrated b and the beam branching unit 4 straightly to the narrow-band-ized means 1, it was lost that the optical path of a resonator bends, the resonance system was stabilized and

the multi-wavelength oscillation in accordance with vibration was lost.
Compared with the etalon, to heat, since it was stable, the wavelength drift of c and the angular dispersion mold wavelength selection component 1 was lost. It is based on things etc.
Drawing 3 shows the example of a concrete configuration of the angular dispersion mold wavelength selection component unit 1 shown in drawing 1.
In drawing 3 (a), the dispersing prism 100 and the high reflective mirror 101 are made to realize the angular dispersion mold wavelength selection component unit 1. In addition, you may make it constitute the angular dispersion mold wavelength selection component unit 1 by combining two or more prism and beam expanders. In drawing 3 (b), the high reflective mirror 102 and a diffraction grating 103 are combined, and these are considered as oblique incidence arrangement. In addition, a beam expander may be further combined to these configurations.
In drawing 3 (c), the prism beam expander 104 and a diffraction grating 105 are combined, and the diffraction grating 105 is considered as RITORO arrangement. In addition, narrow-band-ized effectiveness can be raised more by using the ESHIERU grating with a big blaze angle as a diffraction grating 105.
He is trying for the prism beam expander 106, a dispersing prism 107, and the high reflective mirror 108 to constitute the angular dispersion mold wavelength selection component unit 1 from drawing 3 (d).
Drawing 4 shows the example of a concrete configuration of the beam clinch unit 3 of drawing 1.
He uses flat-surface mirror 301 as a beam clinch unit 3, and is trying to make the optical axis of this flat-surface mirror 301 mostly in agreement with the optical axis of the angular dispersion mold wavelength selection component unit 1 in drawing 4 (a).
He is trying to give an include angle to the optical axis and the optical axis of the angular dispersion mold wavelength selection component unit 1 in drawing 4 (b), using the flat-surface mirror 302 as a beam clinch unit 3.
Drawing 4 (c) is an example at the time of using the convex mirror 303, and drawing 4 (d) is an example at the time of using the concave surface mirror 304. If a convex or a concave surface mirror is used, the divergence angle of beams can be adjusted, and the rate of the light which carries out incidence to the angular dispersion mold wavelength selection component unit 1, and the light taken out as an output light can be optimized, consequently the beautiful laser beam of spectrum distribution can be taken out in high efficiency.
Furthermore, by arranging the cylindrical mirror of a convex or a concave surface, and arranging the machine shaft of this mirror perpendicularly mostly to the distributed flat surface of an angular dispersion mold wavelength selection component instead of the above-mentioned convex mirror 303 and the concave surface mirror 304, it is more efficient and a good output light of a spectrum distribution configuration is obtained.
Next, drawing 5 is the top view showing one more concrete example of this invention.
As an alternate long and short dash line m shows, the optical axis of the high reflective mirror 31 is made in agreement [using the plane high reflective mirror 31 as a beam clinch unit 3] with the optical axis of the angular dispersion mold wavelength selection component unit 1 in this example. He is trying to, use the perforated mirror 42 in which slit-like opening was formed on the other hand as a configuration which can attain the function of the both sides of the beam branching unit 4 of drawing 1, and the beam limit section 5. In this case, the perforated mirror 42 is giving and arranging the include angle of about 45 degrees to said optical axis. The nonreflective slit-like film is prepared in a center section, and you may make it use what carried out the coat of the high reflective film to the other part as this perforated mirror 42. Moreover, the slit 41 is arranged as a configuration which attains the function of the beam limit sections 5 and 6 of drawing 1.
However, the above-mentioned perforated mirror 42 should just arrange a light transmission field and a high reflective field so that a laser beam transparency field may exist in the interior of the laser beam cross section by which outgoing radiation is carried out from the discharge excitation field 23 and the high reflective field which reflects a laser beam in the outside field of the light transmission field may exist.
That is, also in this example, it is made to carry out incidence of the light which has restricted the beam which carries out incidence to the distributed direction of the angular dispersion mold wavelength selection component unit 1 to the angular dispersion mold wavelength selection component unit 1 by fields other than opening (or nonreflective film) of the perforated mirror 42 and which penetrated the perforated mirror 42 straightly to the narrow-band-ized means 1 in this example like the example of previous drawing 1 again.
Furthermore, in order to raise the beam limit effectiveness about the distributed direction of the above-mentioned angular dispersion mold wavelength selection component unit 1, he is trying to arrange a slit 41 between the perforated mirror 42 and the laser tubing 2 in this example. In addition, you may make it form this slit 41 in the beam output light side of the perforated mirror 41 (it is the same as 6 of drawing 1).
Moreover, in this case, the angular dispersion mold wavelength selection component unit 1 consists of a diffraction

grating 11 of RITORO arrangement, and four prism beam expanders 12-15, and, in the case of ArF narrow-band laser, can realize spectral line width of 1 or less pm by these configurations. According to this angular dispersion mold wavelength selection component unit 1, a diffraction grating 11 and any 1 shaft of the prism 12-15 are only rotated, Wavelength can be controlled and high-speed wavelength control can be made. Since the gain of a laser medium is high in addition in the case of excimer laser, if opening of the shape of a slit of the perforated mirror 42 or the magnitude of the nonreflective film, the arrangement include angle of the perforated mirror 42, etc. are adjusted and the rate of the output ejection quantity of light is made 60 - 90%, laser can be oscillated efficiently. In addition, in drawing 5, 21 and 22 are windows and 23 is a discharge excitation field.

Since he is trying to take out output light by the perforated mirror 42 by which opening or the nonreflective film was formed in the center section according to this example, the beam profile (cross-section configuration of a beam) of output light has a form from which the core escaped, as shown in drawing 6 (a). That is, since a discharge excitation field exists between the discharge electrode 24 in the laser tubing 2, and 24' as shown in drawing 6 (b) if the perforated mirror 42 is seen from [of drawing 5] B, the beam profile of output light becomes the thing of an inside omission, as shown in drawing 6 (a).

In addition, in the case of the example of drawing 5, the beam profile of output light is the thing of an inside omission, as mentioned above, but this effect is cancelable by flying a beam in the distance. Moreover, in order that the illumination-light study system of an aligner may acquire high resolving power, when zona-orbicularis lighting or oblique incidence lighting is being performed, efficient lighting is attained, using this beam as it is.

Drawing 7 (a) - (e) enables it to take out the laser beam which has a beam profile without an inside omission as an output light by showing the modification of the example of drawing 5 and using the beam branching unit 4 shown in drawing 7 (a) - (e) instead of the perforated mirror 42 of drawing 5 in this example.

In the beam branching unit 4 shown in drawing 7 (a), as two total reflection mirrors 71 and 72 (coating of the reflective film 73 is carried out to the front face) are arranged not on the same flat surface but on a different flat surface and those arrangement locations are adjusted, it is made not to carry out extraction injury generating at output light. In addition, the angle is dropped in the shape of a taper so that the laser beam which should carry out incidence of the tip 74 of one total reflection mirror 72 to the wavelength selection component unit 1 by this point may not be reflected.

in the beam branching unit 4 of drawing 7 (b), to the optical member 75 by which the shape of surface type of the one side (laser tubing 2 side) be processed into the same configuration as drawing 7 (a), it be a mode as show in drawing 7 (b), and be made not to carry out extraction injury generating by coat the reflective film 73 and an antireflection film 76 at output light.

In the beam branching unit 4 of drawing 7 (c), In a mode as shows the front face by the side of drawing 7 (b) and reverse (wavelength selection component unit 1 side) to drawing 7 (c) to the optical member 75 which processed the same configuration as drawing 7 (a) It is made not to carry out extraction injury generating by coating the reflective film 73 and the antireflection film 76 at output light. Still in this case, output light passes through the inside of the optical member 75, and outgoing radiation is carried out.

In the beam branching unit 4 of drawing 7 (d), it makes it unnecessary to coat said center-section field 77 with the antireflection film 76, as the include angle of said center-section field 77 is set up so that the angle of incidence psi over the center-section field 77 to which coating of the reflective film 73 is not carried out among the front faces by the side of the laser tubing 2 of the optical member 75 may be in agreement with a brewster's angle. In addition, he is trying to form an antireflection film 76 in that center section in this case at the tooth-back side (wavelength selection component unit 1 side) of the optical member 75.

He is trying to set up the include angle of these center-sections fields 77 and 78 in the beam branching unit 4 of drawing 7 (e), so that the angle of incidence psi may be in agreement with a brewster's angle about the both sides of the surface central field 77 of the optical member 75, and the rear-face center-section field 78. It becomes unnecessary for this reason, for a front rear face to coat the antireflection film in this case.

Two total reflection mirrors 71 and 72 of the beam output mirror 70 of previous drawing 7 (a) are connected with the linear movable device 95, and total reflection mirrors 71 and 72 are constituted movable in the direction of C, and it enables it to adjust freely the aperture width W of the beam branching unit 4 by this according to the these linears movable device 95 in drawing 8 next. For this reason, according to this configuration, optimization of the spectral line width of a laser beam and a spectrum distribution configuration can be performed easily. In addition, the reflective mirrors 71 and 72 may enable it to move independently, respectively, and these interlock and you may enable it to move the linear movable device 95 to hard flow in one.

Next, drawing 9 (a) - (e) reduces ASE light, and he is trying to raise the spectral purity of output light by showing the modification of the example of drawing 5 and using other beam clinch units 3 shown in drawing 9 (a) - (e) instead of the

high reflective mirror 31 of the beam clinch unit 3 of drawing 5 in this example.
He is trying for prism 80 and the reflective mirror 81 to constitute the beam clinch unit 3, namely, since ASE light advances in the various directions, it reflects by the reflective mirror 81 and he is trying to spread ASE light out of a narrow-band-ized laser beam by prism 80, and to remove this in drawing 9 (a).
He is trying to fly ASE light by this concavo-convex reflective mirror 82 in drawing 9 (b) in the direction which does not return to the laser tubing 2 using the reflective mirror 82 by which irregularity was formed in the front face.
drawing 9 (c) -- setting -- a lens 83, space APACHI 84, and the concave surface reflective mirror 85 -- the beam clinch unit 3 -- constituting -- the hole of the space aperture 84 -- he is trying to cut ASE light in the part of an except
drawing 9 (d) -- setting -- a lens 86, the space aperture 84, a lens 87, and the flat-surface mirror 88 -- the beam clinch unit 3 -- constituting -- the hole of the space aperture 84 -- he is trying to cut an ASE hole in the part of an except In addition, you may make it arrange a lens 86, the space aperture 84, and a lens 87 between the laser tubing 2 and the perforated mirror 42.
He constitutes the beam clinch unit 3 and is trying to cut ASE light in drawing 9 (e) in parts other than the light of a slit 90 by the cylindrical lens 89, the slit 90, the cylindrical lens 91, and the flat-surface mirror 92. In addition, you may make it arrange a cylindrical lens 89, a slit 90, and a cylindrical lens 91 between the laser tubing 2 and the perforated mirror 42.
Here, in above-mentioned drawing 9 (c) - (e), the space aperture 84 etc. is formed on the optical path in a laser cavity. For this reason, in these configurations, more ASE components are efficiently removable compared with the case where it prepares on the optical path of the output light after reflecting a space aperture etc. by the perforated mirror 42, for example.
In addition, it transposes to the beam branching unit 4 as showed the perforated mirror 42 to drawing 7, and you may make it prevent carrying out extraction injury generating in output light in the configuration of drawing 9.
Other examples of this invention are shown in drawing 10.
As the perforated mirror 43 is formed, he is trying to prevent the inside omission of output light instead of the perforated mirror 42 of drawing 5 in the example of this drawing 10.
namely, the perforated mirror 42 of previous drawing 5 -- setting -- opening of the shape of that slit -- the perforated mirror 42 -- although he is trying to prepare in a center section mostly, he is trying to form the opening 96 of the shape of that slit in the lower part section on the drawing of the perforated mirror 43 (for opening 96 to be correctly shifted and formed in the side from the core, since this drawing 10 is a top view) in the perforated mirror 43 of drawing 10 Consequently, in this example, incidence of the light of a lower field will be carried out to the angular dispersion mold wavelength selection component unit 1 on the drawing of the laser beams generated from the discharge excitation field 23.
Furthermore, each degree of the high reflective mirror 31 is set up so that the optical axis of the high reflective mirror 31 as a beam clinch unit 3 may be between the lines q which connect the optical axis n of the angular dispersion mold wavelength selection component unit 1, the core of the up quantity reflective field of the perforated mirror 43, and the core of a field of actually reflecting the laser beam of the high reflective mirror 3 or may be in agreement with one of both the shafts n and q in this case.
Also in the example of this drawing 10, since the perforated mirror 43 and the slit 41 have restricted the beam to the direction of angular dispersion of the narrow-band-ized means 1 and it is both made to carry out incidence of the light whose parasitic oscillation is lost and which penetrated the perforated mirror 43 straightly to the narrow-band-ized means 1, it is lost that the optical path of a resonator bends, a resonance system is stabilized and the multi-wavelength oscillation in accordance with vibration is lost. Moreover, there shall be no inside omission about the beam profile of the output laser beam.
Next, drawing 11 (a) is the top view showing the example of a configuration at the time of applying the example shown in drawing 10 to the excimer laser of a discharge excitation mold.
In the beam branching unit 4 of this example, one side (drawing very best side) of the substrate 18 of light transmission nature was coated with the reflective film 73, and the function equivalent to the perforated mirror 43 of drawing 10 is attained by making another side (drawing upper-and-lower-sides side) into a light transmission field. Moreover, it has two incomes with this beam branching unit 4, and in order to restrict the breadth of light and to prevent parasitic oscillation, two gobos 51 and 52 are formed along with the light beam.
Therefore, in this example, the substrate 18 is made into the reflective field and the light transmission field 2 ****s by making into a boundary line a line parallel to the discharge direction (direction which met the discharge electrode 24 and the line which connects 24'), as shown in drawing 11 (b).
That is, also in this example, a light transmission field is allotted to one side from the middle of a substrate 18, and a

light reflex field is allotted to a reverse side like the example of drawing 10, and it is a beam clinch unit 3. As the optical axis of the ** quantity reflective mirror 31 sets up the include angle of the high reflective mirror 31, it is made not to carry out extraction injury generating at output light, so that it may be between the optical axis of the angular dispersion mold wavelength selection component unit 1, and the line which connects the core of the high reflective field of the perforated mirror 43, and the core of the high reflective mirror 3 or may be in agreement with one of both the shafts.
Of course, also in the example of this drawing 11, since the reflective film 73 and gobos 51 and 52 of the beam branching unit 4 have restricted the beam to the direction of angular dispersion of the narrow-band-ized means 1, parasitic oscillation is lost. Moreover, since it is made to carry out incidence of the light which penetrated the beam branching unit 4 straightly to the narrow-band-ized means 1, it is lost that the optical path of a resonator bends, a resonance system is stabilized and the multi-wavelength oscillation in accordance with vibration is lost.
Moreover, in this case, in the direction (the direction of illustration E) perpendicular to the discharge direction, the substrate 18 is constituted by the linear stage 44 so that it may be movable, and thereby, it can adjust the rate of output light and the light by which incidence is carried out to the angular dispersion mold wavelength selection component unit 1.
furthermore, the direction (the perpendicular direction of the divergence angle of beams is [a laser beam] smaller compared with the discharge direction to the discharge direction) where the angle of divergence of a laser beam is small in this example and the direction of angular dispersion of an angular dispersion mold wavelength selection component -- about -- since I do one and it is moreover made the beam division direction, the discharge direction, and the right angle, spectrum distribution with very narrow spectral line width is acquired.
In addition, although the reflective section and the transparency section were prepared on the substrate by performing coating of the reflective film to some substrates 18 in this example, a lower light transmission field is deleted on the drawing of the substrate 18 of drawing 11 (a), and it is good also considering this field as mere space.
Drawing 12 (a) - (c) shows still more nearly another example of this invention, and he is trying to divide into two the substrate 18 which constitutes the beam branching unit 4 to a reflective field and a light transmission field in this example, by making into a boundary line a line perpendicular to the discharge direction (direction which met the discharge electrode 24 and the line which connects 24'), as shown in drawing 12 (b). Moreover, a slit 61 is formed between the beam branching unit 4 and the wavelength selection component unit 1, and the slit 62 is further formed also in the beam output light side. Therefore, the light transmission field side divided [above-mentioned] two consists of a light transmission field which penetrates light by the slit 61, and a field which are scattered about and absorbs light. That is, as a beam is restricted to the direction of angular dispersion of the narrow-band-ized means 1, he is trying to control parasitic oscillation in this example by the reflective film 73 and slits 61 and 62 of the beam branching unit 4. Moreover, the substrate 18 is constituted by the linear stage 44 so that it may be movable in a direction (the direction of F of drawing 11 (c)) parallel to the discharge direction, and he is trying to adjust by this the rate of output light and the light by which incidence is carried out to the angular dispersion mold wavelength selection component unit 1 also in this example.
In addition, also in this example, the attitude angle of the clinch mirror 3 is set up so that the optical axis of the high reflective mirror 31 may be between the optical axis of the angular dispersion mold wavelength selection component unit 1, and the line which connects the core of the reflective field of the perforated mirror 43, and the core of the high reflective mirror 3 or may be in agreement with one of both the shafts.
Drawing 13 shows other examples of this invention.
In drawing 13, the AR coat 19 for P polarization (dielectric multilayers) is given to the prism 12-15 which constitutes the angular dispersion mold wavelength selection component unit 1, and the inside of the angular dispersion mold wavelength selection component unit 1 can pass now only P polarization wave (the plane of polarization has the plane of polarization of the same direction as the direction of angular dispersion of the angular dispersion mold wavelength selection component unit 1 namely, is parallel to space) with the AR coat 19 for these P polarization. That is, the light narrow-band-ized in the angular dispersion mold wavelength selection component unit 1 turns into P polarization.
On the other hand, the mirror side of the perforated mirror 43 carries out total reflection only of the P polarization, and absorbs or penetrates S polarization.
Therefore, incidence is carried out to the wavelength selection component 1 through the puncturing slit of the perforated mirror 43, and only P polarization wave is narrow-band-ized, and P polarization wave and S polarization wave which were generated in the discharge excitation field are again returned to a discharge excitation field, and are amplified here. This amplified light is turned up by the mirror 3, passes through a discharge excitation field again, and is amplified further. And while only P polarization wave by which incidence was carried out is reflected and outputted to the mirror side of the perforated mirror 43 in the narrow-band-ized light which came out of the laser tubing 2, incidence of the

light by which incidence was carried out to the slit of the perforated mirror 43 is again carried out to the wavelength selection component 1. On the other hand, while S polarization wave is absorbed or penetrated in respect of the mirror of the perforated mirror 43, scatter reflection of it is carried out on AR coat for P polarization of each prism 12-15 in the wavelength selection component unit 1.
Thus, since S polarization wave of P polarization wave generated in the discharge excitation field and the S polarization waves is not narrow-band-ized according to the above-mentioned example, all S polarization waves serve as ASE light. Moreover, since scatter reflection of this S polarization wave is carried out on AR coat of each prism 12-15 and it is absorbed or penetrated in respect of the mirror of the perforated mirror 43, it becomes possible to reduce ASE light sharply as a result.
Drawing 14 shows each laser spectrum wave the case where the perforated mirror 43 which carries out total reflection of PS both the polarization is used, and at the time of using the perforated mirror 43 which reflects only P polarization in the configuration of drawing 13.
When the perforated mirror 43 which reflects only P polarization like the example of drawing 13 is used so that clearly also from this drawing, an ASE component can be made more nearly mostly than the case where the perforated mirror 43 which carries out total reflection of PS both the polarization is used into one half.
In addition, when S polarization wave is made to penetrate the mirror side of the perforated mirror 43, it is necessary to arrange the slit 45 which has the almost same slit width as the slit of the perforated mirror 43, and to restrict the beam width of S polarization wave which penetrates a mirror side by this slit 45.
Moreover, P polarization of narrow-band light can be done by arranging in a resonator the transparency mold optical element in which the direction of P polarization of the reflection factor in the front face of a transparency mold optical element with incident angles other than a perpendicular (0 degree) had incident angles other than a perpendicular, or the incident angle of a brewster's angle using being fewer than S polarization. Therefore, if this approach is used, even if it does not give AR coat to the prism in a wavelength selection component unit, P polarization is realizable to some extent.

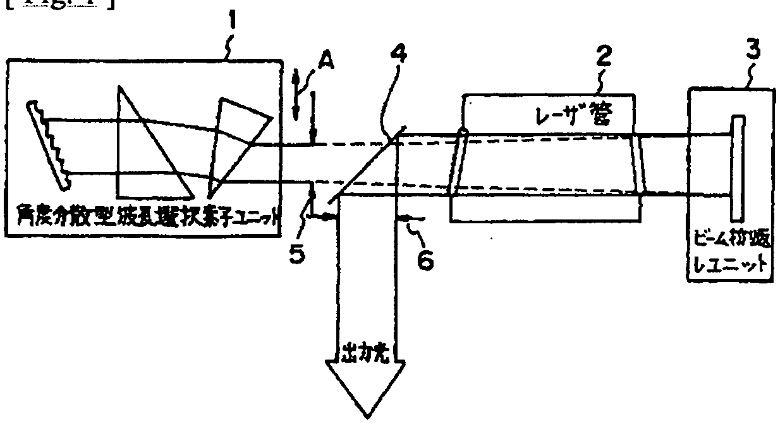
Moreover, there is technique, such as performing elsewhere coating which the optical element which makes only P polarization penetrate is arranged [coating], or makes only P polarization penetrate (for example, between the window 21 by the side of outgoing radiation and the perforated mirrors 43) to a window 21 as the technique of narrow-band-izing only P polarization from the window 21 of the output side of laser before a diffraction grating 11.
Drawing 15 shows the modification of the example of drawing 13, and if an ASE component value is detected and a detection value exceeds a predetermined value, it judges that it is unusual and he is trying to report it to the semi-conductor aligner 99 in this example.
That is, in this example, that by which P polarization and S polarization reflect the coating 19 of P polarization transparency in ****** and the perforated mirror 43 is used for prism 12-15 so that all the narrow-band-ized light may turn into P polarization. Into the optical path which output light furthermore passes, the polarization mirror 46 of P polarization transparency and S polarization reflection is arranged.
Therefore, in this case, as a final output light, only P polarization wave will be taken out and this will be inputted into an aligner 99. On the other hand, incidence is carried out to photosensor 97 and S polarized wave reflected by the polarization mirror 46 is **. A controller 98 reports abnormalities to an aligner 93, when the optical reinforcement of an output laser beam, wavelength, etc. are detected based on the detection value of photosensor 97, the abnormalities of an output laser beam are judged based on these detection values and abnormalities are judged.
In addition, S polarization component is narrow-band-ized and you may make it take out S polarization component as an output light in the example of drawing 13 or drawing 15.
Next, still more nearly another example of this invention is shown in drawing 16.
the configuration of external optical system, such as a power monitor attached to a resonator and this as takes out in the direction which met in the direction of the optical axis of the resonator which has arranged laser output light in the shape of a straight line mostly in this example, and a wavelength monitor, etc. -- a compact -- and he is trying to simplify
For this reason, he passes the laser tubing 2 and is trying to output the output light taken out by the beam branching unit 8 in this example. or [moreover, / grazing the discharge excitation field 24 a little, in case the laser tubing 2 is passed in this case] -- or he is trying to adjust the installation include angle of the beam clinch unit 3 and the beam branching unit 3 so that it may not graze at all In addition, it is also required to adjust the installation include angle of the beam clinch unit 3 and the beam branching unit 3 so that the flat surface (it is a field parallel to space in this case) where the field containing the laser beam by which incidence is carried out from the discharge excitation field 24 to the beam branching unit 3 in this case, and the laser beam reflected in this beam branching unit 3 is perpendicular to the discharge direction may become parallel.

Here, also in this example, since it is made to carry out incidence of the light which penetrated the beam branching unit 8 straightly to the narrow-band-ized means 1, the optical path of a resonator does not bend, a resonance system is stabilized, and the multi-wavelength oscillation in accordance with vibration is lost.
Next, drawing 17 shows the modification of the example of drawing 16, after it makes the discharge excitation field 24 penetrate and amplifies the output light reflected in the beam branching unit 8 in this case, he is trying to output, the output of laser increases further by this, and its narrow-band power efficiency improves. In order to make output light incline to the discharge excitation field 24 furthermore and to make it pass, an ASE component does not carry out ******** generating at output light, and the fall in beam mode does not occur.
In addition, when output light passes near the mirror 3 by return and is outputted, using the optical member made into the total reflection field and the transparency field 2 ****s, the clinch of a laser beam is performed in the total reflection field of this optical member, and it may be made to set in the example of drawing 16 and drawing 17, and to penetrate output light in a transparency field instead of the clinch mirror 3.
Next, drawing 18 shows the modification of the example of drawing 17, and it makes the discharge excitation field 24 penetrate, and he is trying to amplify the output light reflected in the beam branching unit 8 also in this example. However, in this operation, the beam branching unit 8 is installed so that he may prepare the antireflection film in that center section, and he may try to form the reflective film 73 in that outside and the beam branching unit 8 may become almost perpendicular to the optical axis of a laser beam.
On the other hand between the laser tubing 2 and the beam clinch unit 3, the beam branching unit 4 which consists of two total reflection mirrors 72 and 73 shown in previous drawing 7 (a) is arranged, and the laser beam by which incidence was carried out from the laser tubing 2 in this beam branching unit 4 is branched in the laser beam and output light to the beam clinch unit 3.
Thus, in this example, since the beam branching unit 8 has restricted the beam to the direction of angular dispersion of the narrow-band-ized means 1 and it is made to carry out incidence of the light which penetrated the beam branching unit 8 straightly to the narrow-band-ized means 1 while parasitic oscillation is lost, it is lost that the optical path of a resonator bends, a resonance system is stabilized and the multi-wavelength oscillation in accordance with vibration is lost. Furthermore, since a laser beam passes through the discharge excitation field 24 again in this example in addition to this and it is amplified, the output of laser increases further and narrow-band power efficiency improves.
In addition, you may make it constitute the beam branching unit 8 of drawing 18 from a mirror with puncturing, and may make it constitute it from two mirrors.
By the way, in the above example, although the optical element of angular dispersion molds, such as prism and a diffraction grating, is used as a narrow-band-ized component, the wavelength selection component using repeat reflection like an etalon may be used.
Availability on industry This invention applies to narrow-band laser equipments, such as excimer laser equipment used as the aligner of a semi-conductor, or the light source for optical processing, and is useful.

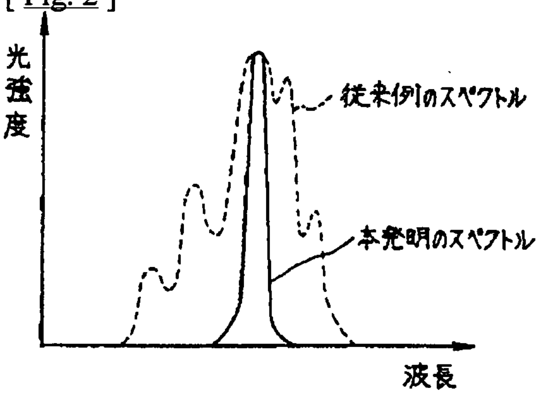
[Translation done.]

DRAWINGS

[Fig. 1]

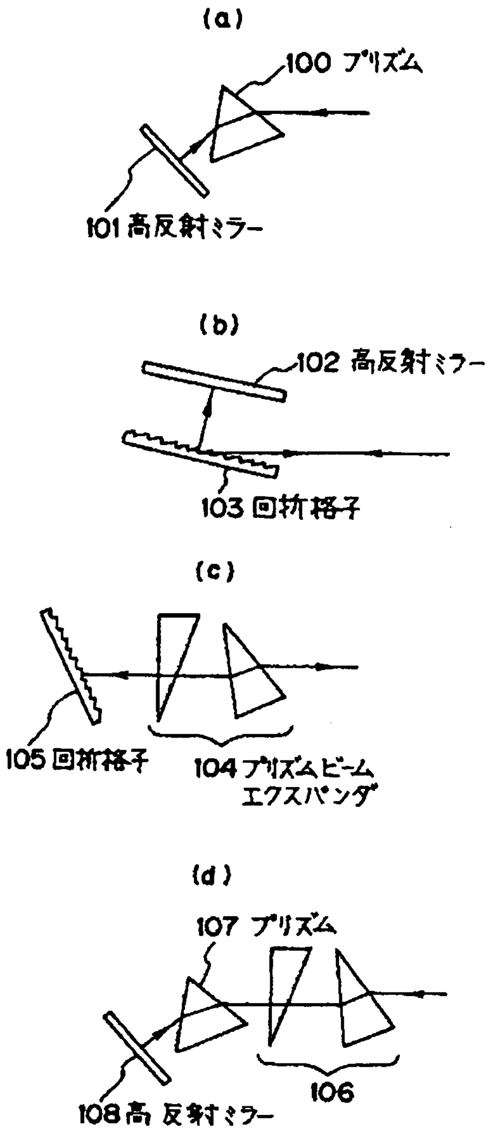


[Fig. 2]

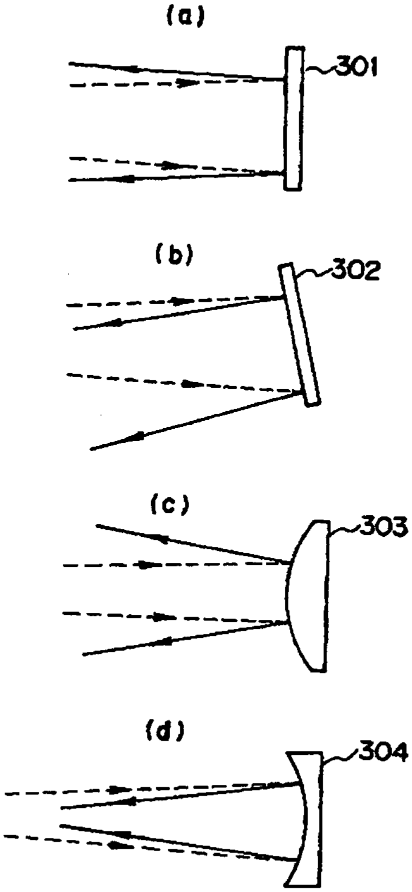


[Fig. 3]

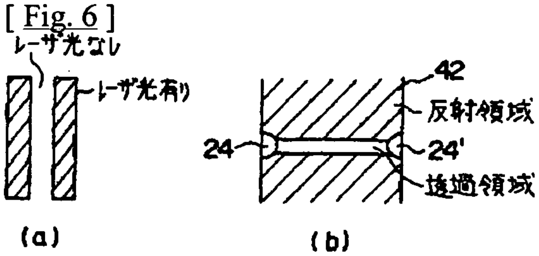
2/16


(a)
100 プリズム
101 高反射ミラー
(b)
102 高反射ミラー
103 回折格子
(c)
105 回折格子
104 プリズムビーム
エクスパンダ
(d)
107 プリズム
106
108 高反射ミラー

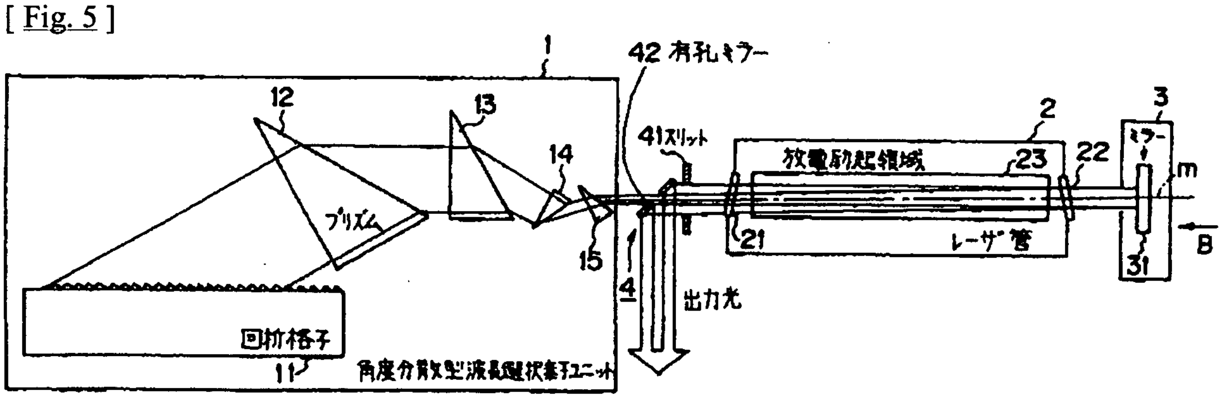
[Fig. 4]



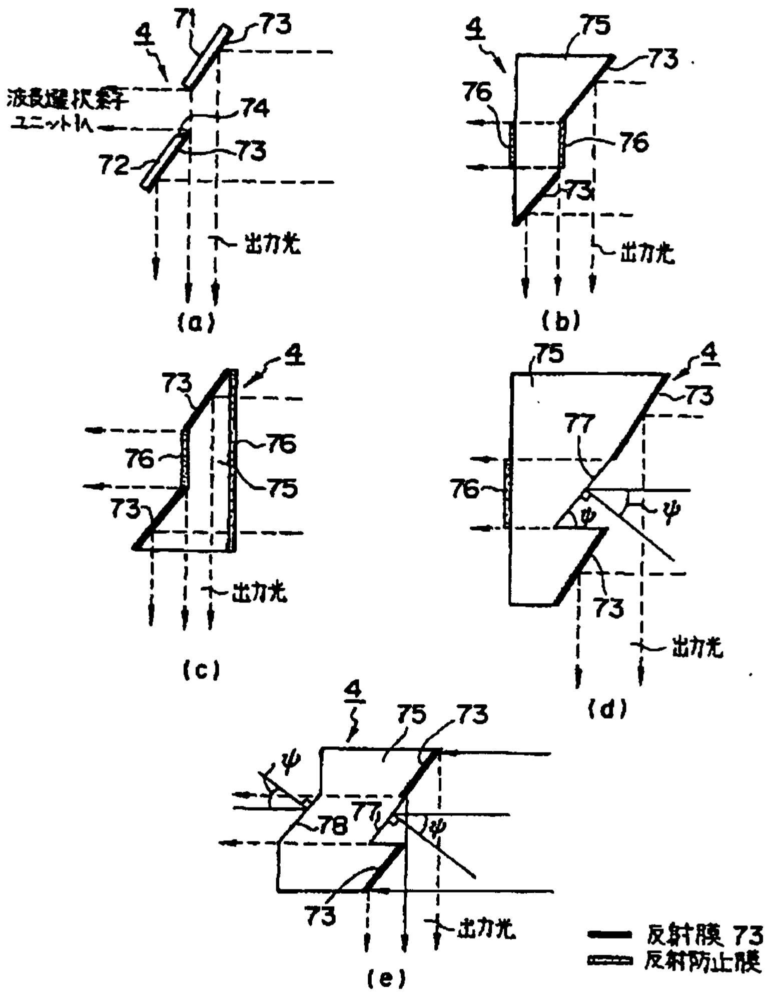
[Fig. 6]



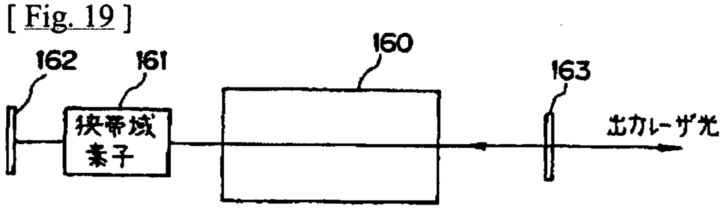
[Fig. 5]



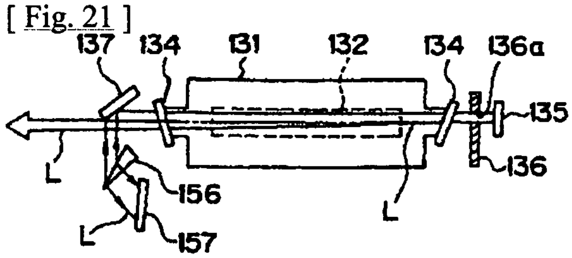
[Fig. 7]



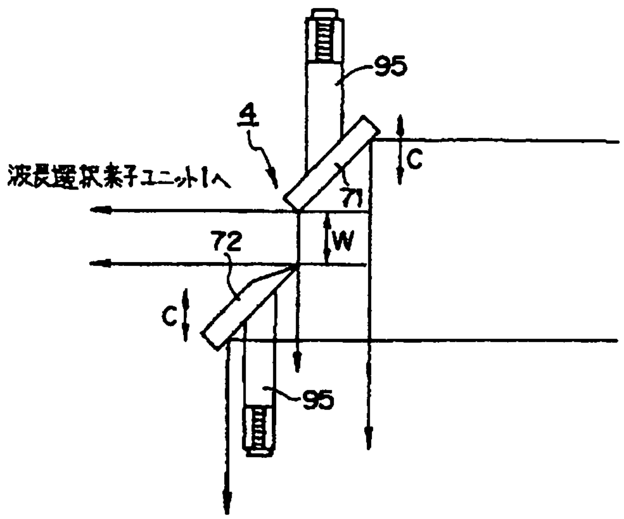
[Fig. 19]



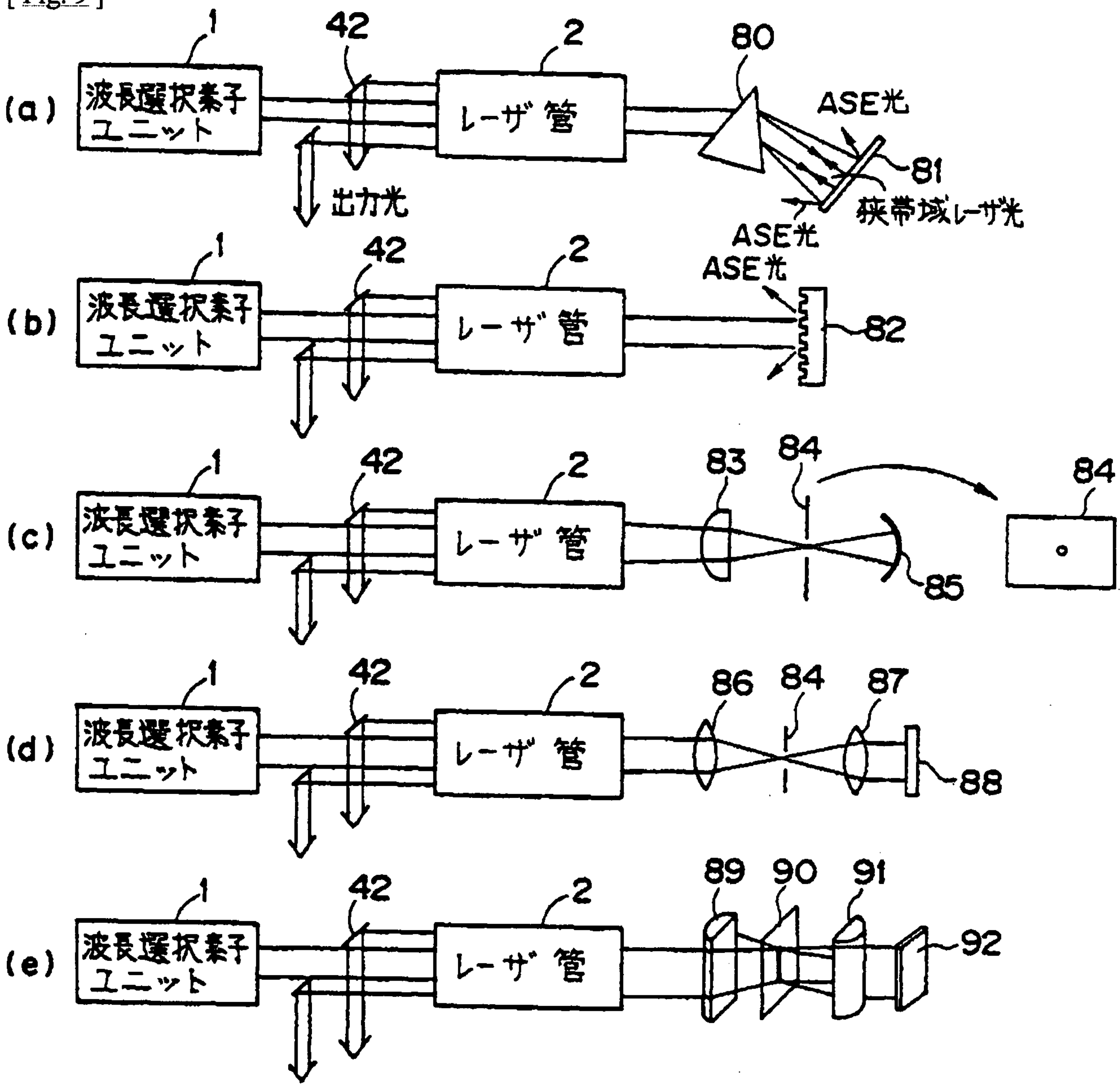
[Fig. 21]



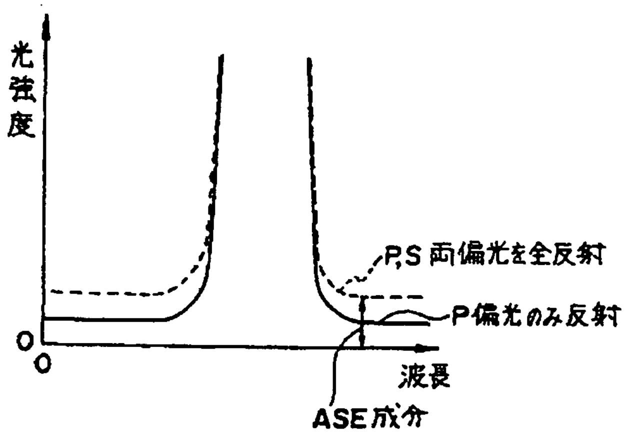
[Fig. 8]


95
4
波長選択素子ユニット1へ
C
71
72
W
C
95

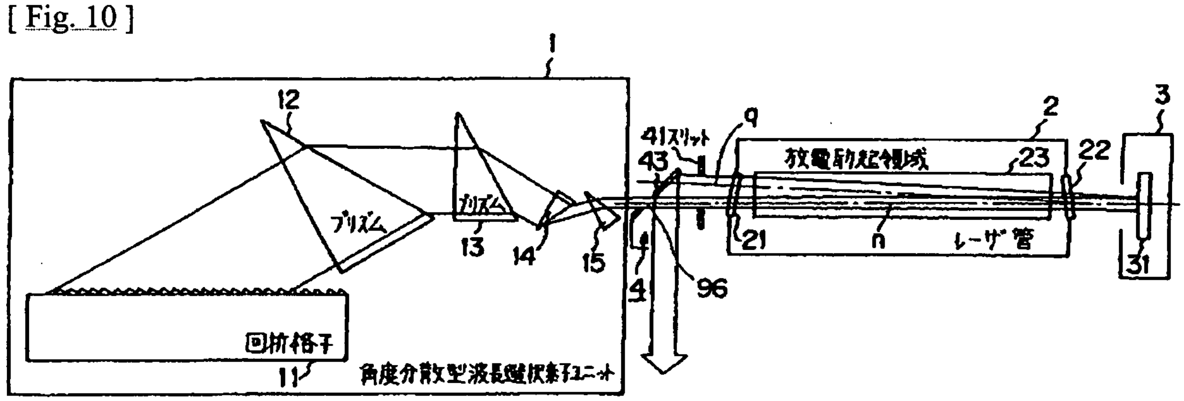
[Fig. 9]


(a)
1
波長選択素子ユニット
42
2
レーザ管
80
ASE光
81
狭帯域レーザ光
ASE光
出力光
(b)
波長選択素子ユニット
レーザ管
ASE光
82
(c)
波長選択素子ユニット
レーザ管
83
84
85
84
(d)
波長選択素子ユニット
レーザ管
86
84
87
88
(e)
波長選択素子ユニット
レーザ管
89
90
91
92

[Fig. 14]

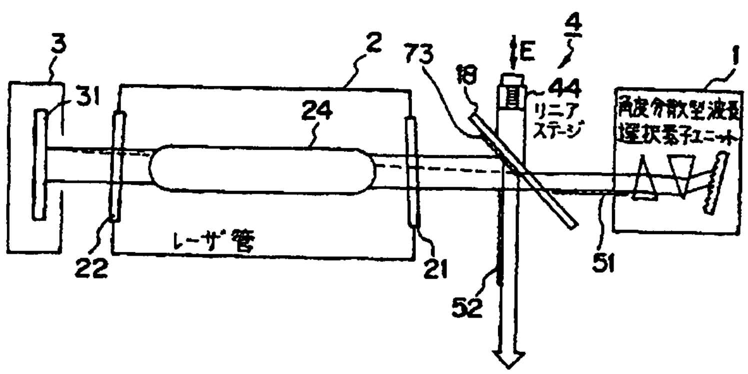


[Fig. 10]

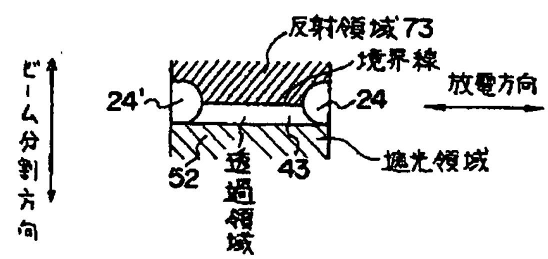


[Fig. 11]

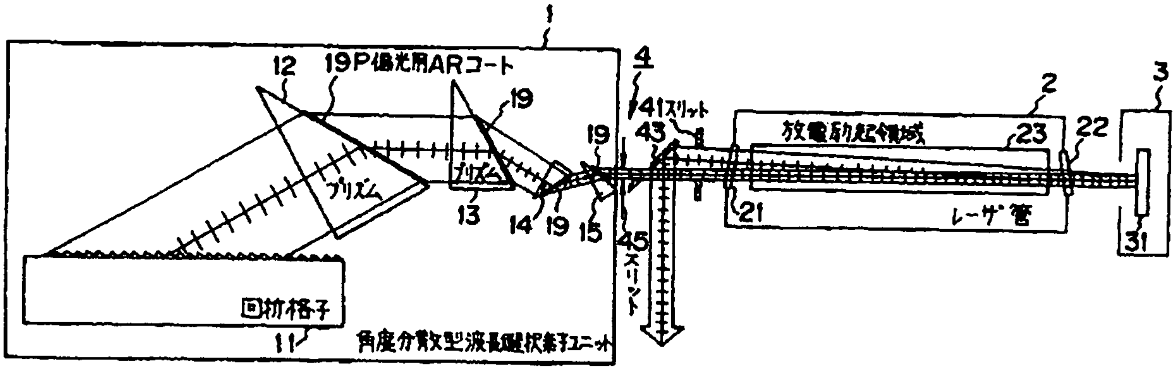
(a)



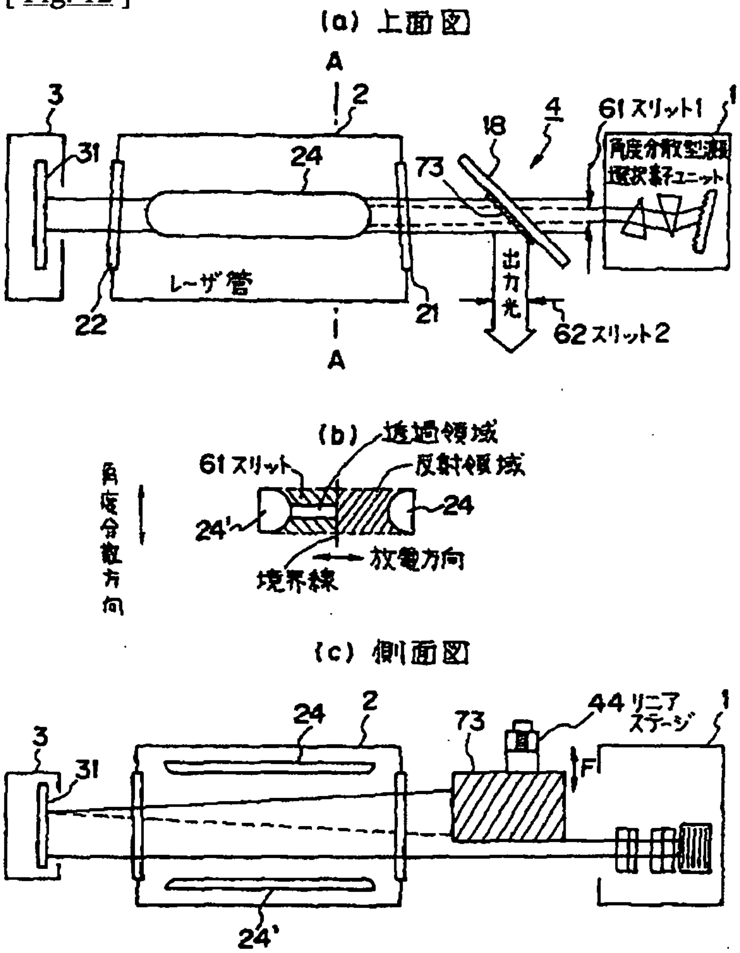
(b)



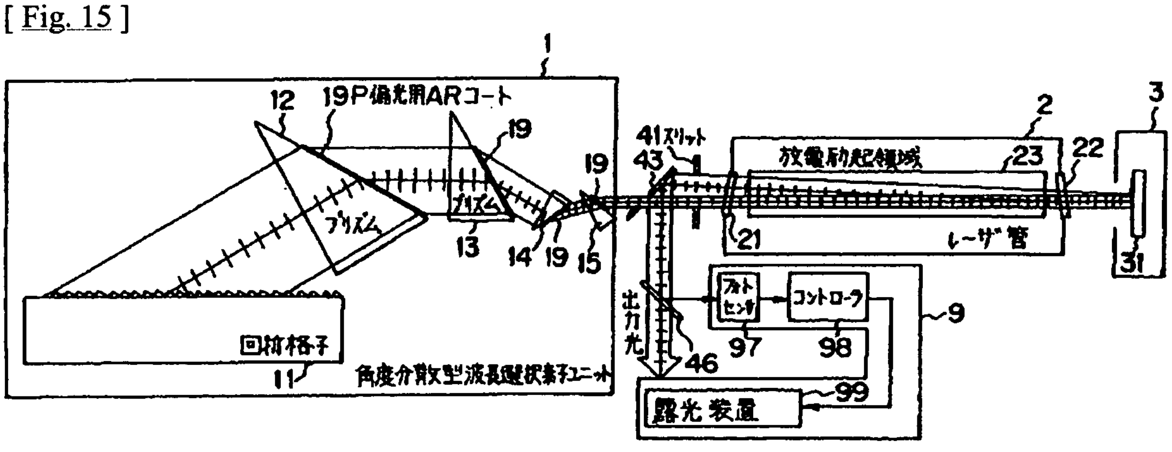
[Fig. 13]



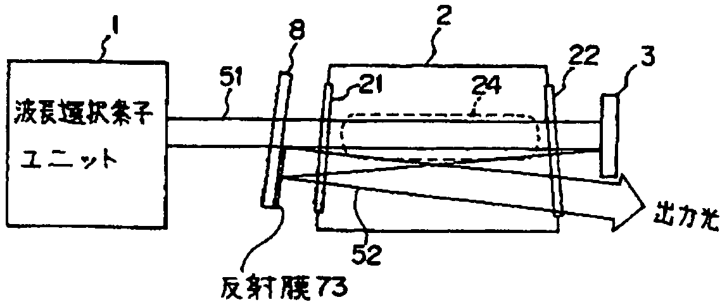
[Fig. 12]



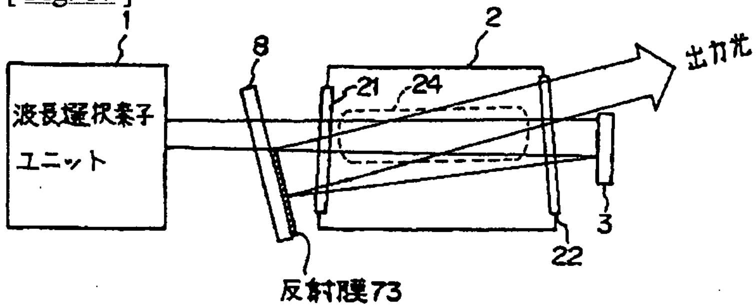
[Fig. 15]



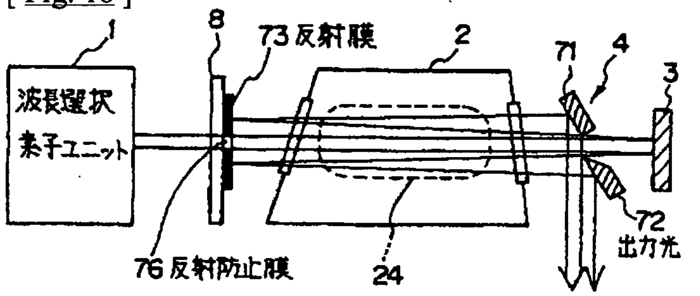
[Fig. 16]



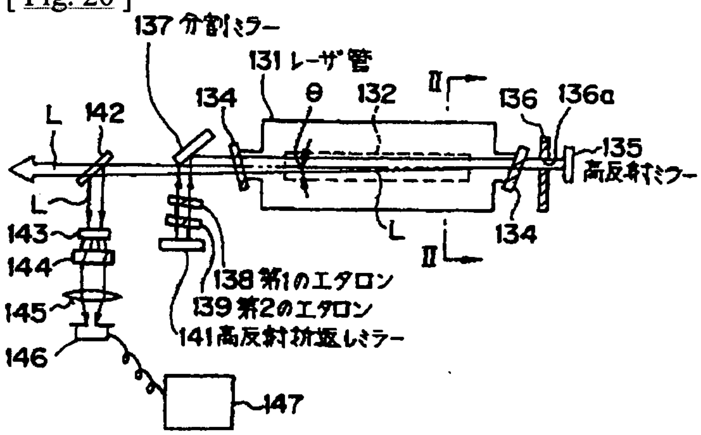
[Fig. 17]



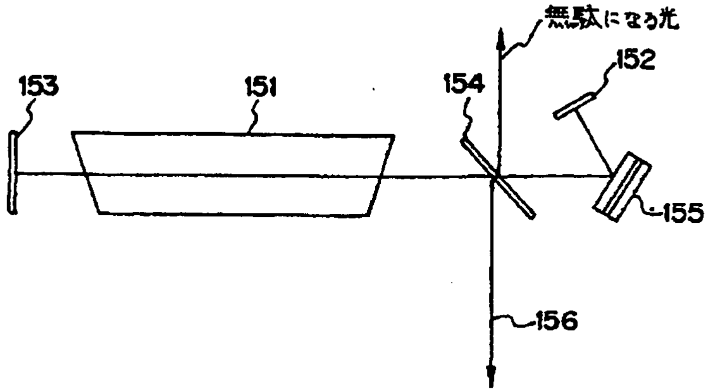
[Fig. 18]



[Fig. 20]



[Fig. 22]



[Translation done.]